

1 **WHAT IS CLAIMED IS:**

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3 1. In a data network, a method of accessing an object in a meta file system
4 stored in a network file server, the meta file system including a plurality of file system
5 cells, the method comprising:

6 a network client sending a directory lookup request for the object to the network
7 file server;

8 the network file server receiving the directory lookup request, and in response,
9 performing a directory lookup for the object, and returning to the network client a file
10 handle for the object, the file handle including an identifier of a file system cell including
11 the object, and a pointer to the object in the file system cell;

12 the network client receiving the file handle for the object, sending to the network
13 file server a request for access to the object, the request for access to the object including
14 the file handle for the object; and

15 the network file server receiving the request for access to the object, and in
16 response, the network file server extracting the file system cell identifier and the object
17 pointer from the file handle included in the request for access, using the file system cell
18 identifier to find the file system cell that includes the object, and using the object pointer
19 to find the object in the file system cell.

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21 2. The method as claimed in claim 1, wherein:
22 in response to the directory lookup request, the network file server also includes
23 in the file handle an indication that the object is not in online storage, and

1 in response to the request for access to the object, the network file server inspects
2 the file handle included in the request for access, and upon inspecting the file handle and
3 finding the indication that the object is not in online storage, the network file server
4 begins a process of moving the object from offline storage to online storage.

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6 3. The method as claimed in claim 1, wherein the network client and the
7 network file server use the Network File System (NFS) protocol when communicating
8 the directory lookup request and the request for access to the object.

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10 4. The method as claimed in claim 1, wherein the network client and the
11 network file server use the Common Internet File System (CIFS) protocol when
12 communicating the directory lookup request and the request for access to the object.

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14 5. The method as claimed in claim 1, wherein the file system cells are file
15 system cells of a Unix-based file system, and the network file server accesses the Unix-
16 based file system to obtain the pointer to the object in the file system cell, and the pointer
17 to the object in the file system cell is a Unix-based file identifier.

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19 6. The method as claimed in claim 1, wherein the network file server
20 includes a plurality of processors, and each of the file system cells has a respective one of
21 the processors that is assigned exclusive management of metadata of said each of the file
22 system cells, and wherein the network file server responds to the file access request by
23 accessing a routing table with the extracted identifier of the file system cell in order to

1 obtain a pointer to the respective one of the processors that is assigned exclusive
2 management of metadata of the file system cell including the object, and using the
3 pointer to the respective one of the processors to send a request to the respective one of
4 the processors for management of metadata of the file system cell for accessing the
5 object.

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7 7. The method as claimed in claim 6, which includes the network file server
8 finding a reference to another one of the file system cells during the accessing of the
9 object after using the pointer to the respective one of the processors, and accessing the
10 routing table to find a pointer to the respective one of the processors that is assigned
11 exclusive management of metadata of said another one of the file system cells, and using
12 the pointer to the respective one of the processors that is assigned exclusive management
13 of metadata of said another one of the file system cells to send a request to the respective
14 one of the processor that is assigned exclusive management of metadata of said another
15 one of the file system cells for access to metadata of said another one of the file system
16 cells.

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18 8. The method as claimed in claim 6, wherein the routing table includes a
19 plurality of entries, and each entry includes a respective file system identifier of a file
20 system cell in the meta file system, and an associated pointer to the respective one of the
21 processors assigned exclusive management of the metadata of the file system cell
22 identified by said respective file system identifier of a file system cell in the meta file
23 system, and the method includes the network file server accessing the entry of the routing

1 table containing the file system identifier of the file system cell including the object in
2 order to obtain the associated pointer to the respective one of the processors assigned
3 exclusive management of the metadata of the file system cell including the object.
4

5 9. The method as claimed in claim 6, wherein the routing table includes a
6 plurality of entries, and each entry includes a respective file system identifier of a file
7 system cell in the meta file system, and an associated pointer to a file system cell object
8 containing a pointer to the respective one of the processors assigned exclusive
9 management of the metadata of the file system cell identified by said respective file
10 system identifier of a file system cell in the meta file system, and the method includes the
11 network file server accessing the entry of the routing table containing the file system
12 identifier of the file system cell including the object in order to obtain the associated
13 pointer to the respective file system cell object containing the pointer to the respective
14 one of the processors assigned exclusive management of the metadata of the file system
15 cell including the object.
16

17 10. A method of accessing an object in a meta file system stored in a network
18 file server, the network file server including a cached disk array and a plurality of data
19 mover computers for moving data between the cached disk array and a data network, the
20 meta file system including a plurality of file system cells, each of the file system cells
21 having a respective one of the data mover computers assigned exclusive management of
22 metadata of said each of the file system cells, said method comprising:

23 storing a routing table in each of the plurality of data mover computers, each of

1 the plurality of routing tables including an entry for each file system cell, each entry
2 including a respective file system cell identifier and associating the respective file system
3 cell identifier with a pointer to the respective one of the data mover computers assigned
4 exclusive management of metadata of the file system cell identified by said respective
5 file system cell identifier;

6 in response to the network file server receiving a request from the network for a
7 file handle for a file, the network file server producing a file handle for the file, the file
8 handle containing a file identifier obtained from the file system cell and a file system
9 identifier for the file system cell containing the file; and

10 at least one of the data mover computers receiving a subsequent request from the
11 network for access to the file, the request for access to the file including the file handle,
12 said at least one of the data movers responding to the request for access to the file by
13 accessing the routing table to obtain the pointer to the respective one of the data movers
14 assigned exclusive management of metadata of the file system cell containing the file in
15 order to obtain management of metadata of the file system cell containing the file in order
16 to access to the file.

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18 11. The method as claimed in claim 10, wherein the step of producing the file
19 handle includes interpreting a meta file system path specification associated with the file.

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21 12. The method as claimed in claim 10, wherein each entry of the routing
22 table includes a respective pointer to a respective file system cell object containing
23 information associated with the file system cell identified by said respective file system

cell identifier in said each entry, the information associated with the file system cell including a pointer to the data mover assigned exclusive management of metadata of the file system identified by said respective file system cell identifier in said each entry.

13. The method as claimed in claim 12, wherein the respective file system cell object includes a local/remote flag indicating whether or not said at least one of the data mover computers is assigned exclusive management of metadata of the file system identified by said respective file system cell identifier in said each entry.

14. The method as claimed in claim 12, wherein the respective file system cell object includes a specification of a communication protocol to be used by said at least one of the data mover computers for communicating with the data mover assigned exclusive management of metadata of the file system identified by said respective file system cell identifier in said each entry.

15. The method as claimed in claim 10, wherein the request from the network for a file handle and the subsequent request from the network for access to the file are communicated over the network using the Network File System (NFS) protocol.

16. The method as claimed in claim 10, wherein the request from the network for a file handle and the subsequent request from the network for access to the file are communicated over the network using the Common Internet File System (CIFS) protocol.

1 17. A network file server comprising data storage for storing a meta file
2 system, the meta file system including a plurality of file system cells, and the network file
3 server having at least one network port coupled to the data storage for providing network
4 clients with access to the meta file system in the data storage, wherein the network file
5 server is programmed for:

6 receiving, from a network client, a directory lookup request for an object in the
7 meta file system, and in response, performing a directory lookup for the object, and
8 returning to the network client a file handle for the object, the file handle including an
9 identifier of a file system cell including the object, and a pointer to the object in the file
10 system cell; and

11 receiving, from the network client, a request for access to the object, the request
12 for access to the object including the file handle for the object, and in response to receipt
13 of the request for access to the object, extracting the file system cell identifier and the
14 object pointer from the file handle included in the request for access, using the file system
15 cell identifier to find the file system cell that includes the object, and using the object
16 pointer to find the object in the file system cell.

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18 18. The network file server as claimed in claim 17, wherein the network file
19 server is also programmed to respond to the directory lookup request by also including in
20 the file handle an indication that the object is not in online storage, and

21 the network file server is also programmed to respond to the request for access to
22 the object by inspecting the file handle included in the request for access, and upon
23 inspecting the file handle and finding the indication that the object is not in online

1 storage, beginning a process of moving the object from offline storage to online storage.

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3 19. The network file server as claimed in claim 17, wherein the network file
4 server is programmed for using the Network File System (NFS) protocol when sending
5 the directory lookup request and when receiving the request for access to the object.

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7 20. The network file server as claimed in claim 17, wherein the network file
8 server is programmed for using the Common Internet File System (CIFS) protocol when
9 sending the directory lookup request and when receiving the request for access to the
10 object.

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12 21. The network file server as claimed in claim 17, wherein the file system
13 cells are file system cells of a Unix-based file system, and the network file server is
14 programmed for accessing the Unix-based file system to obtain the pointer to the object
15 in the file system cell, and the pointer to the object in the file system cell is a Unix-based
16 file identifier.

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18 22. The network file server as claimed in claim 17, wherein the network file
19 server includes a plurality of processors, and each of the file system cells has a respective
20 one of the processors that is assigned exclusive management of metadata of said each of
21 the file system cells, and wherein the network file server is programmed for responding
22 to the file access request by accessing a routing table with the extracted identifier of the
23 file system cell in order to obtain a pointer to the respective one of the processors that is

1 assigned exclusive management of metadata of the file system cell including the object,
2 and using the pointer to the respective one of the processors to send a request to the
3 respective one of the processors for management of metadata of the file system cell for
4 accessing the object.

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6 23. The network file server as claimed in claim 22, wherein the network file
7 server is programmed for finding a reference to another one of the file system cells
8 during the accessing of the object after using the pointer to the respective one of the
9 processors, and accessing the routing table to find a pointer to the respective one of the
10 processors that is assigned exclusive management of metadata of said another one of the
11 file system cells, and using the pointer to the respective one of the processors that is
12 assigned exclusive management of metadata of said another one of the file system cells to
13 send a request to the respective one of the processor that is assigned exclusive
14 management of metadata of said another one of the file system cells for access to
15 metadata of said another one of the file system cells.

16
17 24. The network file server as claimed in claim 22, wherein the routing table
18 includes a plurality of entries, and each entry includes a respective file system identifier
19 of a file system cell in the meta file system, and an associated pointer to the respective
20 one of the processors assigned exclusive management of the metadata of the file system
21 cell identified by said respective file system identifier of a file system cell in the meta file
22 system.

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1 25. The network file server as claimed in claim 22, wherein the routing table
2 includes a plurality of entries, and each entry includes a respective file system identifier
3 of a file system cell in the meta file system, and an associated pointer to a file system cell
4 object containing a pointer to the respective one of the processors assigned exclusive
5 management of the metadata of the file system cell identified by said respective file
6 system identifier of a file system cell in the meta file system.

7
8 26. A network file server including a cached disk array and a plurality of data
9 mover computers for moving data between a data network and a meta file system stored
10 in the cached disk array, the meta file system including a plurality of file system cells,
11 each of the file system cells having a respective one of the data mover computers
12 assigned exclusive management of metadata of said each of the file system cells;

13 said network file server being programmed for storing a routing table in each of
14 the data mover computers, the routing table in each of the data mover computers
15 including an entry for each file system cell, each entry including a respective file system
16 cell identifier and associating the respective file system cell identifier with a pointer to
17 the respective one of the data mover computers assigned exclusive management of
18 metadata of the file system cell identified by said respective file system cell identifier;

19 said network file server being programmed for responding to receipt of a request
20 from the network for a file handle for a file by producing a file handle for the file, the file
21 handle containing a file identifier obtained from the file system cell and a file system
22 identifier for the file system cell containing the file; and

23 at least one of the data mover computers being programmed for receiving a

1 subsequent request from the network for access to the file, the request for access to the
2 file including the file handle, said at least one of the data movers being further
3 programmed for responding to the request for access to the file by accessing the routing
4 table in said at least one of the data mover computers to obtain the pointer to the
5 respective one of the data movers assigned exclusive management of metadata of the file
6 system cell containing the file in order to obtain management of metadata of the file
7 system cell containing the file in order to access to the file.

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9 27. The network file server as claimed in claim 26, wherein the network file
10 server is programmed for interpreting a meta file system path specification associated
11 with the file in order to produce the file handle for the file.

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13 28. The network file server as claimed in claim 26, wherein each entry of the
14 routing table in said at least one of the data mover computers includes a respective
15 pointer to a respective file system cell object containing information associated with the
16 file system cell identified by said respective file system cell identifier in said each entry,
17 the information associated with the file system cell including a pointer to the data mover
18 assigned exclusive management of metadata of the file system identified by said
19 respective file system cell identifier in said each entry.

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21 29. The network file server as claimed in claim 28, wherein the respective file
22 system cell object includes a local/remote flag indicating whether or not said at least one
23 of the data mover computers is assigned exclusive management of metadata of the file

1 system identified by said respective file system cell identifier in said each entry.

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3 30. The network file server as claimed in claim 28, wherein the respective file
4 system cell object includes a specification of a communication protocol to be used by
5 said at least one of the data mover computers for communicating with the data mover
6 assigned exclusive management of metadata of the file system identified by said
7 respective file system cell identifier in said each entry.

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9 31. The network file server as claimed in claim 26, wherein the network file
10 server is programmed for using the Network File System (NFS) protocol for
11 communicating the request from the network for a file handle and the subsequent request
12 from the network for access to the file.

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14 32. The network file server as claimed in claim 26, wherein the network file
15 server is programmed for using the Common Internet File System (CIFS) protocol for
16 communicating the request from the network for a file handle and the subsequent request
17 from the network for access to the file.

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